

**What is claimed is:**

1. A method to compress a matrix, the method comprising:

partitioning the matrix into a set of overlapping sub-blocks  $\{m_k, k = 1, \dots, V\}$  ;

weighting each sub-block  $m_k$  by a weight matrix  $w_k$  to form a weighted sub-block  $m_k * w_k$ , where  $w_k$  has the same dimension as  $m_k$  and  $*$  denotes element-by-element multiplication, wherein  $m_k * w_k$  has a decomposition

$$m_k * w_k = \sum_{i=1}^{N(k)} \sigma_i(k) u_i(k) v_i'(k);$$

and representing each weighted sub-block  $m_k * w_k$  by a set of scalar weights

$\{\sigma_i(k), i = 1, \dots, n(k)\}$ , a set of vectors  $\{u_i(k), i = 1, \dots, n(k)\}$ , and a set of vectors

$\{v_i(k), i = 1, \dots, n(k)\}$ , where  $n(k) \leq N(k)$ .

2. The method as set forth in claim 1, wherein the matrix has elements

$M(i, j), i = 1, \dots, P; j = 1, \dots, Q$  where  $P$  and  $Q$  are the number of rows and the number of

columns, respectively, of the matrix, wherein the weight matrices  $w_k, k = 1, \dots, V$  are

such that for any image pixel element  $M(i, j)$ , the sum of all weight elements in the set

of weight matrices  $w_k, k = 1, \dots, V$  multiplying  $M(i, j)$  when weighting each sub-block

$m_k$  by  $w_k$  is a predetermined value.

3. The method as set forth in claim 2, wherein the predetermined value is unity.

4. The method as set forth in claim 2, wherein

for each  $k$ , the decomposition

$$m_k * w_k = \sum_{i=1}^{N(k)} \sigma_i(k) u_i(k) v_i'(k)$$

is the singular value decomposition of the weighted sub-block  $m_k * w_k$ .

5. The method as set forth in claim 4, wherein for each index  $k$ ,  $n(k)$  is

the smallest index  $i$  for which  $\sigma_{i+1}(k) < C$ , where  $C$  is a positive constant, the singular

values are such that  $\sigma_1(k) \geq \sigma_2(k) \geq \dots \geq \sigma_{N(k)}(k)$ , and if there is no such smallest

integer, then  $n(k) = N(k)$ .

6. The method as set forth in claim 1, wherein

for each  $k$ , the decomposition

$$m_k * w_k = \sum_{i=1}^{N(k)} \sigma_i(k) u_i(k) v_i'(k)$$

is the singular value decomposition of the weighted sub-block  $m_k * w_k$ .

7. The method as set forth in claim 6, wherein for each index  $k$ ,  $n(k)$  is

the smallest index  $i$  for which  $\sigma_{i+1}(k) < C$ , where  $C$  is a positive constant, the singular

values are such that  $\sigma_1(k) \geq \sigma_2(k) \geq \dots \geq \sigma_{N(k)}(k)$ , and if there is no such smallest

integer, then  $n(k) = N(k)$ .

8. The method as set forth in claim 6, wherein there is at least one  $k$  for which  $n(k) < N(k)$ .

9. The method as set forth in claim 6, wherein  $n(k) = \min\{C, N(k)\}$ , where  $C$  is independent of  $k$ .

10. An article of manufacture comprising a computer readable medium, the computer readable medium comprising instructions to cause a computer system to:

partition a matrix into a set of overlapping sub-blocks  $\{m_k, k = 1, \dots, V\}$ ;

weight each sub-block  $m_k$  by a weight matrix  $w_k$  to form a weighted sub-block  $m_k * w_k$ , where  $w_k$  has the same dimension as  $m_k$  and  $*$  denotes element-by-element multiplication, wherein  $m_k * w_k$  has a decomposition

$$m_k * w_k = \sum_{i=1}^{N(k)} \sigma_i(k) u_i(k) v_i'(k);$$

and represent each weighted sub-block  $m_k * w_k$  by a set of scalar weights  $\{\sigma_i(k), i = 1, \dots, n(k)\}$ , a set of vectors  $\{u_i(k), i = 1, \dots, n(k)\}$ , and a set of vectors  $\{v_i(k), i = 1, \dots, n(k)\}$ , where  $n(k) \leq N(k)$ .

11. The method as set forth in claim 10, wherein the matrix has elements  $M(i, j), i = 1, \dots, P; j = 1, \dots, Q$  where  $P$  and  $Q$  are the number of rows and the number of columns, respectively, of the matrix, wherein the weight matrices  $w_k, k = 1, \dots, V$  are such that for any image pixel element  $M(i, j)$ , the sum of all weight elements in the set

of weight matrices  $w_k$ ,  $k=1,\dots,V$  multiplying  $M(i,j)$  when weighting each sub-block  $m_k$  by  $w_k$  is a predetermined value.

12. The method as set forth in claim 11, wherein the predetermined value is unity.

13. The method as set forth in claim 11, wherein  
for each  $k$ , the decomposition

$$m_k * w_k = \sum_{i=1}^{N(k)} \sigma_i(k) u_i(k) v_i'(k)$$

is the singular value decomposition of the weighted sub-block  $m_k * w_k$ .

14. The method as set forth in claim 13, wherein for each index  $k$ ,  $n(k)$  is the smallest index  $i$  for which  $\sigma_{i+1}(k) < C$ , where  $C$  is a positive constant, the singular values are such that  $\sigma_1(k) \geq \sigma_2(k) \geq \dots \geq \sigma_{N(k)}(k)$ , and if there is no such smallest integer, then  $n(k) = N(k)$ .

15. The article of manufacture as set forth in claim 10, wherein  
for each  $k$ , the decomposition

$$m_k * w_k = \sum_{i=1}^{N(k)} \sigma_i(k) u_i(k) v_i'(k)$$

is the singular value decomposition of the weighted sub-block  $m_k * w_k$ .

16. The article of manufacture as set forth in claim 15, wherein for each index  $k$ ,  $n(k)$  is the smallest index  $i$  for which  $\sigma_{i+1}(k) < C$ , where  $C$  is a positive constant, the singular values are such that  $\sigma_1(k) \geq \sigma_2(k) \geq \dots \geq \sigma_{N(k)}(k)$ , and if there is no such smallest integer, then  $n(k) = N(k)$ .
17. The article of manufacture as set forth in claim 15, wherein there is at least one  $k$  for which  $n(k) < N(k)$ .
18. The article of manufacture as set forth in claim 15, wherein  $n(k) = \min\{C, N(k)\}$ , where  $C$  is independent of  $k$ .
19. A method to compress a matrix, the method comprising:  
partitioning the matrix into a set of overlapping sub-blocks  $\{m_k, k = 1, \dots, V\}$ ,  
where each  $m_k$  has a decomposition
- $$m_k = \sum_{i=1}^{N(k)} \sigma_i(k) u_i(k) v_i'(k);$$
- and representing each sub-block  $m_k$  by a set of scalar weights  $\{\sigma_i(k), i = 1, \dots, n(k)\}$ , a set of vectors  $\{u_i(k), i = 1, \dots, n(k)\}$ , and a set of vectors  $\{v_i(k), i = 1, \dots, n(k)\}$ , where  $n(k) \leq N(k)$ .
20. The method as set forth in claim 19, wherein  
for each  $k$ , the decomposition

$$m_k = \sum_{i=1}^{N(k)} \sigma_i(k) u_i(k) v_i'(k)$$

is the singular value decomposition of the sub-block  $m_k$ .

21. The method as set forth in claim 20, wherein for each index  $k$ ,  $n(k)$  is the smallest index  $i$  for which  $\sigma_{i+1}(k) < C$ , where  $C$  is a positive constant, the singular values are such that  $\sigma_1(k) \geq \sigma_2(k) \geq \dots \geq \sigma_{N(k)}(k)$ , and if there is no such smallest integer, then  $n(k) = N(k)$ .

22. The method as set forth in claim 20, wherein there is at least one  $k$  for which  $n(k) < N(k)$ .

23. The method as set forth in claim 20, wherein  $n(k) = \min\{C, N(k)\}$ , where  $C$  is independent of  $k$ .

24. An article of manufacture comprising a computer readable medium, the computer readable medium comprising instructions to cause a computer system to:

partition a matrix into a set of overlapping sub-blocks  $\{m_k, k = 1, \dots, V\}$ , wherein  $m_k$  has a decomposition

$$m_{k_i} = \sum_{i=1}^{N(k)} \sigma_i(k) u_i(k) v_i'(k);$$

and represent each sub-block  $m_k$  by a set of scalar weights  $\{\sigma_i(k), i = 1, \dots, n(k)\}$ ,  
a set of vectors  $\{u_i(k), i = 1, \dots, n(k)\}$ , and a set of vectors  $\{v_i(k), k = 1, \dots, N(k)\}$ , where  
 $n(k) \leq N(k)$ .

25. The article of manufacture as set forth in claim 24, wherein  
for each  $k$ , the decomposition

$$m_k = \sum_{i=1}^{N(k)} \sigma_i(k) u_i(k) v_i'(k)$$

is the singular value decomposition of the sub-block  $m_k$ .

26. The article of manufacture as set forth in claim 25, wherein for each index  $k$ ,  
 $n(k)$  is the smallest index  $i$  for which  $\sigma_{i+1}(k) < C$ , where  $C$  is a positive constant, the  
singular values are such that  $\sigma_1(k) \geq \sigma_2(k) \geq \dots \geq \sigma_{N(k)}(k)$ , and if there is no such  
smallest integer, then  $n(k) = N(k)$ .

27. The article of manufacture as set forth in claim 25, wherein there is at least one  $k$   
for which  $n(k) < N(k)$ .

28. The article of manufacture as set forth in claim 25, wherein  $n(k) = \min\{C, N(k)\}$ ,  
where  $C$  is independent of  $k$ .

29. A method to synthesize a matrix  $\hat{M}$ , the method comprising:

receiving families of sets comprising:

a family of sets of scalar weights  $\{\{\sigma_i(k), i = 1, \dots, n(k)\}, k = 1, \dots, V\}$ ;

a family of sets of vectors  $\{\{u_i(k), i = 1, \dots, n(k)\}, k = 1, \dots, V\}$ ; and

a family of sets of vectors  $\{\{v_i(k), i = 1, \dots, n(k)\}, k = 1, \dots, V\}$ ;

forming weighted vector outer products and summing to provide  $\hat{m}_k, k = 1, \dots, V$

where

$$\hat{m}_k = \sum_{i=1}^{n(k)} \sigma_i(k) u_i(k) v_i'(k);$$

and overlaying  $\hat{m}_k$  for  $k = 1, \dots, V$  and summing to provide the synthesized

matrix  $\hat{M}$ .

30. An article of manufacture comprising a readable computer medium, the readable computer medium comprising instructions to cause a computer system to synthesize a matrix  $\hat{M}$  by

receiving families of sets comprising:

a family of sets of scalar weights  $\{\{\sigma_i(k), i = 1, \dots, n(k)\}, k = 1, \dots, V\}$ ;

a family of sets of vectors  $\{\{u_i(k), i = 1, \dots, n(k)\}, k = 1, \dots, V\}$ ; and

a family of sets of vectors  $\{\{v_i(k), i = 1, \dots, n(k)\}, k = 1, \dots, V\}$ ;

forming weighted vector outer products and summing to provide  $\hat{m}_k, k = 1, \dots, V$

where

$$\hat{m}_k = \sum_{i=1}^{n(k)} \sigma_i(k) u_i(k) v_i'(k);$$



and overlaying  $\hat{m}_k$  for  $k = 1, \dots, V$  and summing to provide the synthesized matrix  $\hat{M}$ .

31. A method to synthesize a matrix  $\hat{M}$ , the method comprising:

receiving families of sets comprising:

a family of sets of scalar weights  $\{\{\sigma_i(k), i = 1, \dots, n(k)\}, k = 1, \dots, V\}$ ;

a family of sets of vectors  $\{\{u_i(k), i = 1, \dots, n(k)\}, k = 1, \dots, V\}$ ; and

a family of sets of vectors  $\{\{v_i(k), i = 1, \dots, n(k)\}, k = 1, \dots, V\}$ ;

forming weighted vector outer products and summing to provide  $\hat{m}_k, k = 1, \dots, V$

where

$$\hat{m}_k = \sum_{i=1}^{n(k)} \sigma_i(k) u_i(k) v_i'(k);$$

weighting each  $\hat{m}_k$  by a weight matrix  $w_k$  to form  $\hat{m}_k * w_k$  where  $*$  denotes element-by-element multiplication; and

overlaying  $\hat{m}_k * w_k$  for  $k = 1, \dots, V$  and summing to provide the synthesized matrix  $\hat{M}$ .

32. An article of manufacture comprising a computer readable medium, the computer readable medium comprising instructions to cause a computer system to synthesize a matrix  $\hat{M}$  by

receiving families of sets comprising:

a family of sets of scalar weights  $\{\{\sigma_i(k), i = 1, \dots, n(k)\}, k = 1, \dots, V\}$ ;

a family of sets of vectors  $\{\{u_i(k), i = 1, \dots, n(k)\}, k = 1, \dots, V\}$ ; and

a family of sets of vectors  $\{\{v_i(k), i = 1, \dots, n(k)\}, k = 1, \dots, V\}$ ;

forming weighted vector outer products and summing to provide  $\hat{m}_k, k = 1, \dots, V$

where

$$\hat{m}_k = \sum_{i=1}^{n(k)} \sigma_i(k) u_i(k) v_i'(k);$$

weighting each  $\hat{m}_k$  by a weight matrix  $w_k$  to form  $\hat{m}_k * w_k$  where  $*$  denotes element-by-element multiplication; and

overlaying  $\hat{m}_k * w_k$  for  $k = 1, \dots, V$  and summing to provide the synthesized matrix  $\hat{M}$ .

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